

FINAL DRAINAGE REPORT

910 28TH STREET

AT

910 28TH STREET

BOULDER, COLORADO 80305

FOR

BRICKSTONE PARTNERS

JULY 25, 2011

July 25, 2011

Mr. Jeff Arthur
City of Boulder - Engineering Development Review
1739 Broadway
Boulder, CO 80306

RE: 910 28th Street
Final Drainage Report
JVA Job No. 1852c

Dear Jeff:

The following Final Drainage Report and attached drainage map for the first phase of the 910 28th Street project at 910 28th Street has been prepared for the above referenced project. The drainage report and drainage map have been produced in accordance with the "City of Boulder Design and Construction Standards," 2000 Edition, and comply with provisions thereof.

It is our understanding that the information provided herein meets all requirements of the City of Boulder's drainage criteria.

Please contact us if you have any questions regarding this submission.


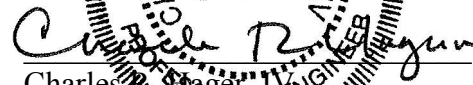
Sincerely,
JVA, Inc.

Charlie R. Hager IV, P.E.
Vice President

ENGINEER'S STATEMENT:

"I hereby certify that this report and the enclosed plan for the Final Drainage design of 910 28th Street project were prepared in accordance with the provisions of the City of Boulder Design and Construction Standards for the Responsible Parties thereof. I understand that the City of Boulder does not and shall not assume liability for drainage facilities designed by me."

Signature:



Charles R. Hager
Registered Professional Engineer
State of Colorado No. 37146

FINAL DRAINAGE REPORT

910 28TH STREET

AT

910 28TH STREET

BOULDER, COLORADO 80305

FOR THE

BRICKSTONE PARTNERS

2990 17TH STREET, SUITE 702

DENVER, CO 80206

JVA, Inc.

1319 Spruce Street
Boulder, CO 80302
phone: 303-444-1951
fax: 303-444-1957

JVA Project No. 1852c

July 25, 2011

TABLE OF CONTENTS

Table of Contents 1

Introduction 2

Historic Drainage 2

Proposed (Developed) Drainage 3

Conclusions 5

References 6

APPENDIX

- A - Vicinity Map and FIRM Flood Map
- B - Hydraulic Calculations and References

FIGURE 1 – DEVELOPED DRAINAGE MAP

FINAL DRAINAGE REPORT

INTRODUCTION

GENERAL LOCATION AND DESCRIPTION

Brickstone Development proposes to redevelop the existing site to create a multi-family complex at 910 28th Street in the City of Boulder. The 0.39-acre site is located in the southwest ¼ of Section 32, Township 1 North, and Range 70 West of the 6th P.M., City of Boulder, County of Boulder, State of Colorado.

PROPOSED PROJECT

The project will be constructed in one phase. The project will include one building: a multi-family structure with underground parking facility and utility service connections. Please refer to the Grading and Drainage Plans prepared by JVA, Inc..

HISTORIC DRAINAGE

MAJOR DRAINAGE BASIN DESCRIPTION

The project lies within the Skunk Creek drainage area. Skunk Creek is located approximately ¼ mile southeast of the site. According to the FEMA Flood Insurance Rate Map Panel Number 08013 C0395 F, dated June 2, 1995, the site is not located in any designated floodplain area. A copy of a portion of the referenced flood map that depicts the site location is included in the Appendix.

SITE DRAINAGE AND EXISTING FACILITIES

The existing site consists of an undeveloped property. The site is bounded to the north by multi-family development (Golden West Manor), a multi-family development bounded along the south and east (Flatirons Village), and to the west by 28th Street.

The site slopes from an elevation of approximately 5344.0 at the west to an elevation of approximately 5328.0 at the east with slopes in the access drive ranging from 1% to over 12% and existing dirt slopes exceed 4H:1V at the west side of the site. The storm runoff from the majority of the existing site currently flows overland to the east into the neighboring property and then southeast to the existing public storm sewer Aurora Avenue. This public storm pipe system then conveys the flows to Skunk Creek.

There are no existing storm drainage or water quality enhancement features on the site. No delineated wetlands have been located on the site.

A drainage analysis was performed to determine the existing runoff from the total site area. The existing site was determined to have 10-year and 100-year runoff rates of 0.38 cfs and 1.31 cfs, respectively, with approximately 34% impervious area as shown in the Appendix of this report.

PROPOSED (DEVELOPED) DRAINAGE

DRAINAGE DESIGN CRITERIA

The proposed private storm drainage facilities for the project are designed to comply with the “City of Boulder Design and Construction Standards,” 2000 Edition, and the Urban Drainage and Flood Control District’s Urban Storm Drainage Criteria Manual (USDCM), June 2001 Edition.

HYDROLOGIC METHOD AND DESIGN STORM FREQUENCIES

The Rational Method ($Q=CIA$) was used to determine the storm runoff (Q) from the areas tributary to the new storm system, with composite runoff coefficients (C) and contributing areas (A) given for design points in sub-basins. The runoff coefficients for various land usages were obtained from the “City of Boulder Design and Construction Standards” and the latest USDCM prescribed methodology. Fall Intensity-Duration-Frequency Values from Figure 7-1, from the “City of Boulder Design and Construction Standards” and the calculated Time of Concentration (T_c).

PROPOSED SITE BASINS

As shown on the attached Figure 1 – Developed Drainage Plan, the entire 0.39 acre site was analyzed to determine the proposed runoff from the total developed site area. The proposed site was divided into five onsite basins.

Basin A1 is located on the south edge of the site which contains the south half of the proposed building and landscaping between the proposed building and property line. Water quality for this basin will be achieved through the cobble water quality infiltration swale.

Basins A2 is located at the east end of the proposed building. Runoff flows from this basin are routed to dry well at the southeast corner of the site.

Basin B1 is located on the north edge of the site which contains the north half of the proposed building. Water quality for this basin will be achieved through the cobble water quality infiltration swale.

Basin OS1 is a small perimeter area on the west side, north side and east side of the future proposed building. Due to site constraints, flows from this basin are unable to be detained or treated with water quality features. These areas are predominantly landscaping and produce almost negligible increases in runoff on existing conditions.

Basin OS2 will be dedicated driveway and access easement to the City of Boulder. Improvements within this basin are limited to access driveway along the north and east sides of the site. Due to site grading constraints, water quality cannot be provided within the Basin.

ONSITE AND OFFSITE RUNOFF

Developed flows from the various basins will be routed via roof drains, downspouts, overland flow, and the onsite storm system to a water quality feature. Due to City of Boulder criteria, developed flows will not increase above the existing flows. No significant offsite drainage enters the site from the surrounding properties.

DETENTION AND WATER QUALITY ENHANCEMENT FACILITIES

The table below outlines existing runoff from the site and developed runoff from the various basins. Total runoff from the developed site will increase slightly from the existing conditions. Flows from basins A1 and B1 will travel through onsite water quality enhancement facilities. Flows from Basins OS1 and OS2 are traveling overland in the same direction as existing historical conditions.

SITE BASIN	AREA (ACRES)	5-yr Release Rate (CFS)	100-yr Release Rate (CFS)
EXISTING (H1)	0.34	0.38	1.31
A1	0.14	0.36	0.77
A2	0.01	0.04	0.08
B1	0.11	0.39	0.77
OS1	0.08	0.11	0.32
DEVELOPED SITE TOTAL	0.34	0.90	1.94

OFF-SITE BASIN	AREA (ACRES)	5-yr Release Rate (CFS)	100-yr Release Rate (CFS)
EXISTING OFF-SITE (HOS-1)	0.13	0.18	0.52
DEVELOPED OFF-SITE TOTAL (OS-2)	0.13	0.48	0.94

The site is less than 1.0 acres; therefore, regulatory water quality features are not mandatory; however water quality enhancement features are provided in various ways throughout the site. The two cobble water quality infiltration swales provide water quality enhancement features for Basins A1 and B1. Extensive grass lined and cobble infiltration swales are located along the north and south side of the proposed building.

Due to the site grading constraints and the lack of an underground storm system in the area, the two water quality facilities will provide water quality for the site. Due to the minor (<0.50 cfs) increase in runoff for the site, storm water detention is not required.

The above described Best Management Practices (BMPs) provide water quality enhancement features to the site. The cobble water quality infiltration swale and grass areas facilitate soil infiltration, which minimizes and cleans flows bound for the City storm system. These BMPs allow slow infiltration of runoff into the ground as well as provide additional water quality features for the storm runoff.

CONCLUSIONS

Stormwater flows from the site will continue to be directed to the easterly side of the site where the runoff will be spread evenly to the neighbors property to the east, then to into the existing City storm sewer at East Aurora Avenue which conveys flows to Skunk Creek drainage area. The developed runoff rates for the proposed site development will will be greater than the existing runoff rates from the site. Water quality features were used at numerous locations. Additional infiltration areas, water quality facilities, and cobble lined swales are provided around the site where feasible.

The recommendations of this report are in conformance with all applicable storm drainage regulations. Calculations, a vicinity map, and other reference materials used are attached in the Appendix.

REFERENCES

1. “City of Boulder Design and Construction Standards,” 2000 Edition.
2. “Urban Storm Drainage Criteria Manual,” Urban Drainage and Flood Control District, June 2001.

APPENDIX A – SITE MAPS

910 28TH STREET

AT

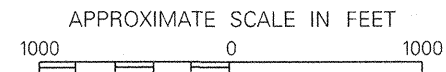
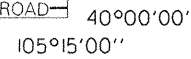
910 28TH STREET

BOULDER, COLORADO 80305



VICINITY MAP

NOT TO SCALE



FIRM

BOULDER COUNTY,
COLORADO AND
INCORPORATED AREAS

PANEL 395 OF 595

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:
COMMUNITY

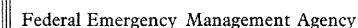
NUMBER	PANEL	SUFFIX
--------	-------	--------

BOULDER COUNTY,
UNINCORPORATED AREAS
BOULDER, CITY OF

080023	0395	F
080024	0395	F

MAP NUMBER
08013C0395 F

EFFECTIVE DATE:
JUNE 2, 1995



This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

APPENDIX B – HYDRAULIC CALCULATIONS



JVA, Incorporated
1319 Spruce Street
Boulder, CO 80302
Ph: 303.444.1951
Fax: 303.444.1957

Job Name: 910 28th Street
Job Number: 1852c
Date: 7/25/2011
By: JMA

910 28th Street Composite Runoff Coefficient & Time of Concentration Calculations

Location:

Minor Design Storm:

Major Design Storm:

2
10

%I (per UDFCD)

Landscaping	10
Paved Streets	100
Asphalt Drives/ Concrete Walks	95
Roofs	95

SOIL TYPE: C/D

%I	
Open Space	10
Gravel	40
Landscaping	10
Pavements	95
Roof	95
Playground	25
Art. Turf	25

Type of Land Surface	Conveyance Coefficient C _v
Heavy Meadow	2.5
Tillage/field	5
Short Pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

Basin Design Data								Runoff Coeff's					Initial Overland Time (t) t _i =0.395(1.1-C _s)L ^{1/2} S ^{-1/3}			Travel Time (t _t) t _t =Length/(Velocity x 60)					t _c Computed	t _c Urbanized Check		t _c Final	
Basin Design	Design Point	A _{landscape} (sf)	A _{paved streets} (sf)	A _{asphalt} drives/ conc walks (sf)		A _{roof} (sf)	A _{Total} (sf)	A _{Total} (ac)	%I	C2	C5	C10	C100	Uppermost		t _i (min)	Length (ft)	Slope (%)	C _v	Velocity (fps)	t _t (min)	Time of Conc t _i + t _t = t _c	Total Length (ft)	t _c =(L/180) +10 (min.)	Minimum t _c = 5 min
OS1	1	1,752		1,547			3,299	0.08	50	0.33	0.39	0.46	0.60	25	2.00	5.1				0.0	5.0	10.1	25	10.1	10.1
OS2	2		4,664	973			5,636	0.13	99	0.87	0.88	0.90	0.95	216	8.50	2.9	0	0.00	0	0.0	5.0	7.9	216	11.2	7.9
A1	3	1,009				4,944	5,953	0.14	81	0.60	0.63	0.66	0.74	60	9.00	3.2	131	5.00	15	3.4	5.0	8.2	191	11.1	8.2
A2	4			460			460	0.01	95	0.80	0.82	0.84	0.89	12	2.00	1.4	24	1.00	20	2.0	5.0	6.4	36	10.2	6.4
B1	5					4,958	4,958	0.11	95	0.80	0.82	0.84	0.89	36	1.00	3.1	36	1.00	20	2.0	5.0	8.1	72	10.4	8.1



JVA, Incorporated
1319 Spruce Street
Boulder, CO 80302
Ph: 303.444.1951
Fax: 303.444.1957

Job Name: 910 28th Street
Job Number: 1852c
Date: 7/25/2011
By: JMA

910 28th Street

Historical Composite Runoff Coefficient & Time of Concentration Calculations

Location:

Minor Design Storm:

Major Design Storm:

2
10

%I (per UDFCD)

Landscaping	10
Paved Streets	100
Asphalt Drives/ Concrete Walks	95
Roofs	95

SOIL TYPE: C/D

%I	
Open Space	10
Gravel	40
Landscaping	10
Pavements	95
Roof	95
Playground	25
Art. Turf	25

Type of Land Surface	Conveyance Coefficient C _v
Heavy Meadow	2.5
Tillage/field	5
Short Pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

Basin Design Data								Runoff Coeff's					Initial Overland Time (t) t=0.395(1.1-C _s)L ^{1/2} S ^{-1/3}			Travel Time (t) t=Length/(Velocity x 60)					t _c Computed	t _c Urbanized Check		t _c Final
Basin Design	Design Point	A _{landscape} (sf)	A _{paved streets} (sf)	A _{asphalt drives/ conc walks} (sf)	A _{roof} (sf)	A _{Total} (sf)	A _{Total} (ac)	%I	C2	C5	C10	C100	Uppermost Length (ft)	Slope (%)	t _i (min)	Length (ft)	Slope (%)	C _v	Velocity (fps)	t _t (min)	Time of Conc t _i + t _t = t _c	Total Length (ft)	t _c =(L/180)) + 10 (min.)	Minimum t _c = 5 min
H1	H1	11,445	2,320	1,031		14,796	0.34	30	0.22	0.30	0.38	0.57	185	8.00	10.0				0.0	5.0	15.0	185	11.0	11.0
HOS1	H2	3,506	2,128	80		5,714	0.13	45	0.30	0.37	0.44	0.59	215	8.00	9.9				0.0	5.0	14.9	215	11.2	11.2



JVA, Incorporated
1319 Spruce Street
Boulder, CO 80302
Ph: 303.444.1951
Fax: 303.444.1957

Job Name:
Job Number:
Date:
By:

910 28th Street

Storm Drainage System Design (Rational Method Procedure)

One Hour Point Rainfall

1.43 CHANGE PER LOCAL VALUES

MINOR 5 YEAR

		Direct Runoff						Total Runoff				Street Flows		Pipe			PIPE Travel Time			Remarks
Design Point	Subbasin Designation	Area (ac)	Runoff Coefficient	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Total tc (min)	ΣC*A (ac)	I (in/hr)	Q (cfs)	Slope (%)	Street flow (cfs)	Pipe Size (in)	Slope (%)	Pipe Flow (cfs)	Length (ft)	Velocity (fps)	tt (min)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	
ON-SITE																				
1	A	0.08	0.39	10.10	0.03	3.85	0.11	-	-	-	0.11					0.11	0	0.11	0.00	
2	B	0.13	0.88	7.90	0.11	4.22	0.48	10.10	0.14	3.85	0.56					0.56	0	0.56	0.00	
3	C	0.14	0.63	8.20	0.09	4.17	0.36	8.20	0.20	4.17	0.84					0.84	0	0.84	0.00	
4	D	0.01	0.82	6.40	0.01	4.52	0.04	8.20	0.09	4.17	0.39					0.39	0	0.39	0.00	
5	E	0.11	0.82	8.10	0.09	4.18	0.39	8.20	0.19	4.17	0.78					0.78	0	0.78	0.00	

EDIT EDIT

One Hour Point Rainfall

2.6 CHANGE PER LOCAL VALUES

MAJOR 100 YEAR

		Direct Runoff						Total Runoff				Street Flows		Pipe			PIPE Travel Time			Remarks
Design Point	Subbasin Designatio n	Area (ac)	Runoff Coefficient	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Total tc (min)	ΣC*A (ac)	I (in/hr)	Q (cfs)	Slope (%)	Street flow (cfs)	Pipe Size (in)	Slope (%)	Pipe Flow (cfs)	Length (ft)	Velocity (fps)	tt (min)	(21)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(13)	(14)	(15)	(16)	(17)	(18)	
ON-SITE																				
1	A	0.08	0.60	10.10	0.05	7.01	0.32	-	-	-	0.32			0	0	0.32	0	0.32	0.00	
2	B	0.13	0.95	7.90	0.12	7.67	0.94	10.10	0.17	7.01	1.17			0	0	1.17	0	1.17	0.00	
3	C	0.14	0.74	8.20	0.10	7.58	0.77	7.90	0.27	7.67	2.06			0	0	2.06	0	2.06	0.00	
4	D	0.01	0.89	6.40	0.01	8.22	0.08	7.90	0.23	7.67	1.79			0	0	1.79	0	1.79	0.00	
5	E	0.11	0.89	8.10	0.10	7.61	0.77	7.90	0.21	7.67	1.63			0	0	1.63	0	1.63	0.00	

EDIT EDIT

* = flow exceeds pipe capacity



JVA, Incorporated
1319 Spruce Street
Boulder, CO 80302
Ph: 303.444.1951
Fax: 303.444.1957

Job Name:
Job Number:
Date:
By:

910 28th Street

Historical Storm Drainage System Design (Rational Method Procedure)

One Hour Point Rainfall

1.43 **CHANGE PER LOCAL VALUES**MINOR **5** YEAR

Design Point	Direct Runoff							Total Runoff				Street Flows		Pipe			PIPE Travel Time			Remarks
	Subbasin Designation	Area (ac)	Runoff Coefficient	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Total tc (min)	ΣC*A (ac)	I (in/hr)	Q (cfs)	Slope (%)	Street flow (cfs)	Pipe Size (in)	Slope (%)	Pipe Flow (cfs)	Length (ft)	Velocity (fps)	tt (min)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
ON-SITE																				
H1	A	0.34	0.30	11.00	0.10	3.72	0.38	-	-	-	0.38					0.38	0	1	0.00	
H2	B	0.13	0.37	11.20	0.05	3.70	0.18	11.00	0.15	3.72	0.56					0.56		1	0.00	

EDIT

EDIT

One Hour Point Rainfall

2.6 **CHANGE PER LOCAL VALUES**MAJOR **100** YEAR

Design Point	Direct Runoff							Total Runoff				Street Flows		Pipe			PIPE Travel Time			Remarks
	Subbasin Designation	Area (ac)	Runoff Coefficient	tc (min)	C*A (ac)	I (in/hr)	Q (cfs)	Total tc (min)	ΣC*A (ac)	I (in/hr)	Q (cfs)	Slope (%)	Street flow (cfs)	Pipe Size (in)	Slope (%)	Pipe Flow (cfs)	Length (ft)	Velocity (fps)	tt (min)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
ON-SITE																				
H1	A	0.34	0.57	11.00	0.19	6.77	1.31	-	-	-	1.31			0	0	1.31	0	1	0.00	
H2	B	0.13	0.59	11.20	0.08	6.72	0.52	11.00	0.27	6.77	1.83			0	0	1.83	0	1	0.00	

EDIT

EDIT

* = flow exceeds pipe capacity

910 28TH STREET
BOULDER, CO 80303

2011 Shears Adkins Rockmore

Date: 07.25.2011

Project Name:
910 28TH STREET
Issued For / Phase:
Building Permit & Tech Docs

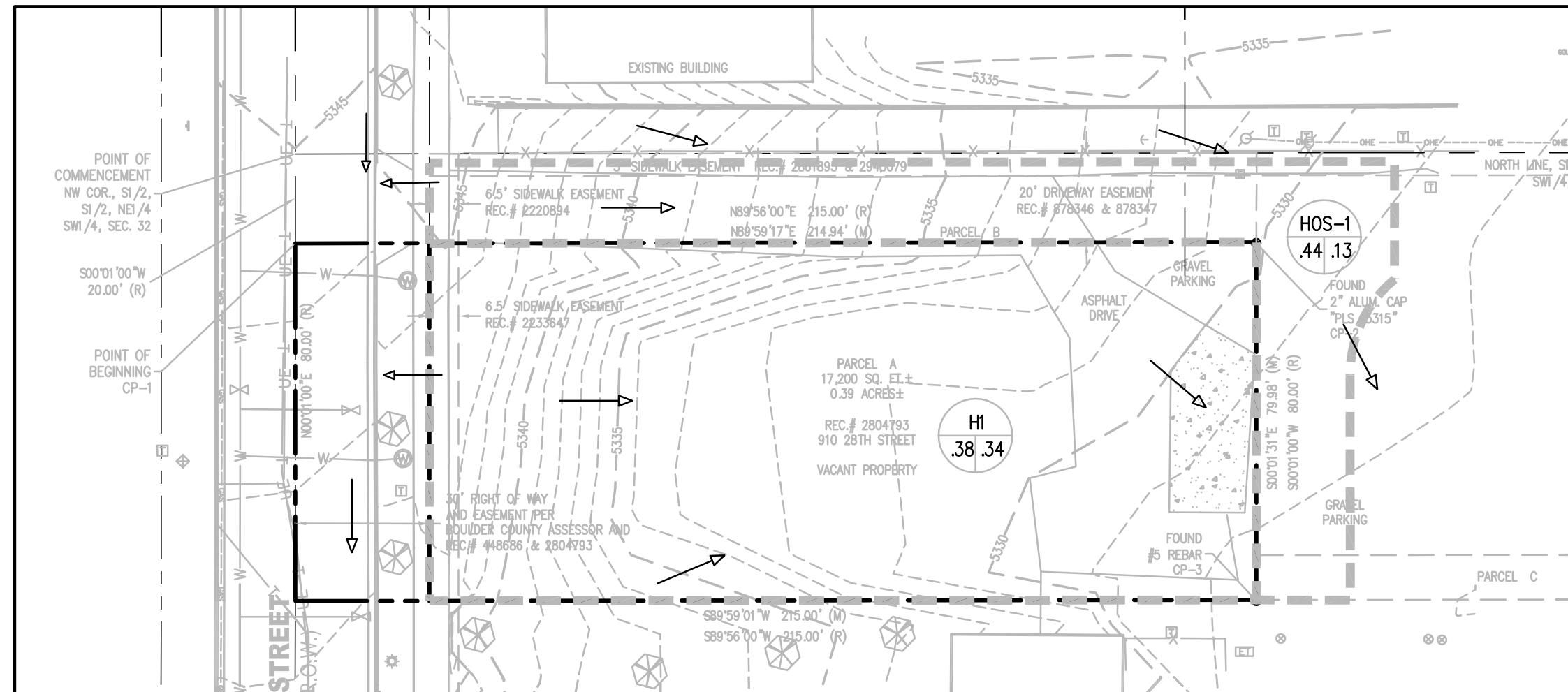
Drawn: MC

Revisions:

Sheet Name:
DRAINAGE MAP

Sheet Number:

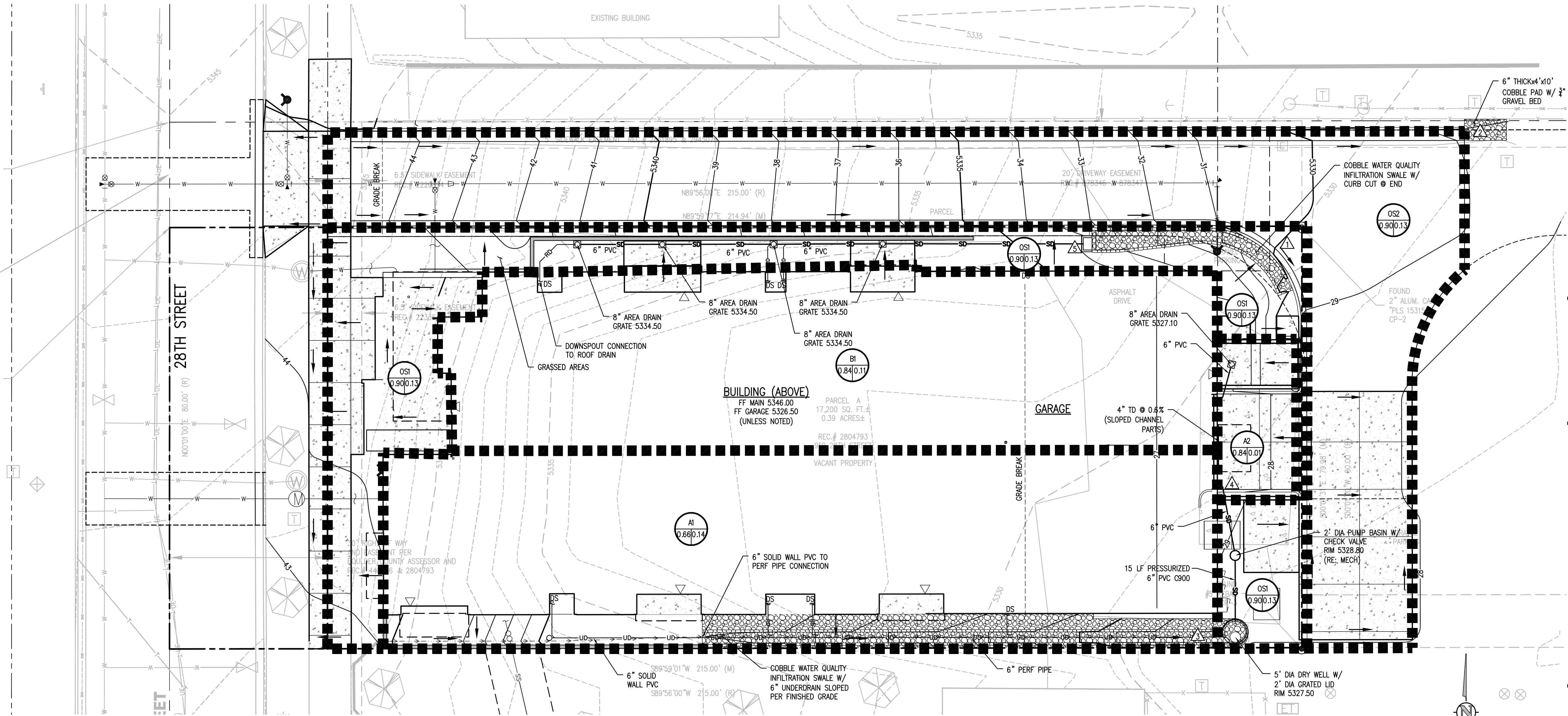
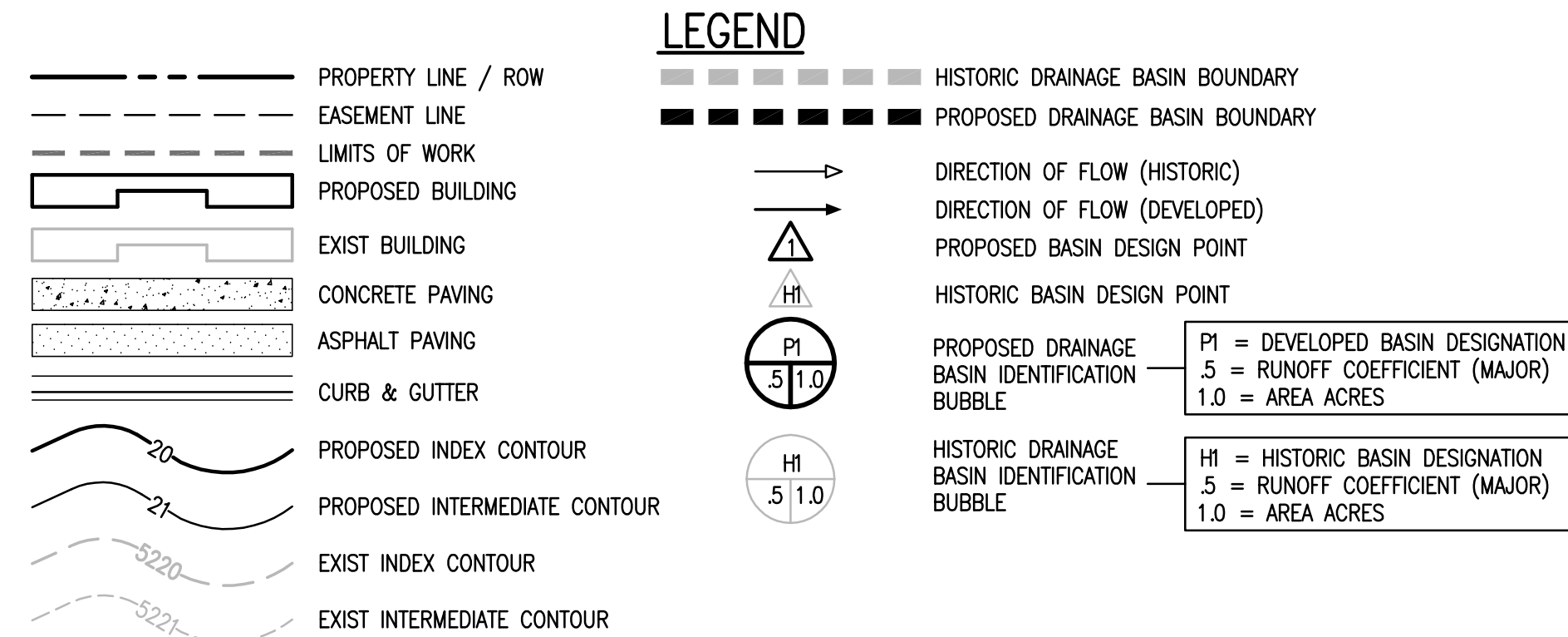
FIG-1



HISTORIC (EXISTING) DRAINAGE MAP
SCALE: 1" = 30'

OFF-SITE RUNOFF SUMMARY TABLE				
BASIN	DESIGN POINT	AREA (ACRES)	5 YR RUNOFF (CFS)	100 YR RUNOFF (CFS)
HISTORIC: 45% IMPERVIOUS				
HOS-1	H2	0.13	0.18	0.52
DEVELOPED: 99% IMPERVIOUS				
OS2	2	0.13	0.48	0.94

SITE RUNOFF SUMMARY TABLE				
BASIN	DESIGN POINT	AREA (ACRES)	5 YR RUNOFF (CFS)	100 YR RUNOFF (CFS)
HISTORIC: 30% IMPERVIOUS				
HI	HI	0.34	0.38	1.31
DEVELOPED: 79% IMPERVIOUS				
OS1	1	0.08	0.11	0.32
A1	3	0.14	0.36	0.77
A2	4	0.01	0.04	0.08
B1	5	0.11	0.39	0.77
TOTAL		0.34	0.90	1.94



NOTES:

1. CONTOUR INTERVAL = 1 FOOT
2. SEE CONSTRUCTION PLANS FOR CONSTRUCTION DETAILS
3. SEE CONSTRUCTION PLANS FOR EROSION CONTROL AND STORMWATER MANAGEMENT PLANS

